Chapter 3: Anatomy and Physiology of the Breast

The breast is a highly efficient and complex organ. In order for health professionals to effectively counsel women about breastfeeding, it is essential that they understand the anatomy of the breast and the physiological processes of milk production.

Breast Anatomy

The breast is an exocrine gland composed of the following parts:

- glandular tissue which produces and transports milk,
- connective tissue which supports the breast,
- blood which nourishes breast tissue and provides the nutrients to the breast needed for milk production,
- lymph which removes waste products,
- nerves which make the breast sensitive to touch, thereby allowing the baby's suck to stimulate the release of hormones that trigger the let-down or milk ejection reflex (MER) and the production of milk, and
- adipose tissue which protects the breast from injury.

• Glandular Tissue

The glandular tissue responsible for producing and transporting milk include the alveoli, ductules, lactiferous ducts, and lactiferous sinuses. Alveoli are epithelial cells that form grape-like clusters of cells. It is in these cells where milk is produced from the blood. These cells are surrounded by a network of band-like myoepithelial cells which cause the alveoli to contract when stimulated by oxytocin. (Oxytocin is released during the MER and will be discussed in more detail under the Physiology section.) This action cause the milk to be expelled from the alveoli into the ductules and down into the ducts.

Ductules are branch-like tubules extending from the clusters of alveoli. Each ductule empties into larger ducts called lactiferous ducts. The lactiferous ducts widen underneath the areola and nipple to become lactiferous sinuses, where the milk collects.

Each mammary gland forms a lobe of the breast, which consists of a single major branch of alveoli, milk ducts, and one lactiferous sinus that narrows to an opening in the nipple (nipple pore). There are fifteen to twenty-five lobes in a breast and each lobe consists of twenty to forty lobules - a smaller milk duct with its supporting alveoli. Each lobule consists of ten to 100 supporting alveoli. Thus, the total number of alveoli varies from three thousand to one hundred thousand during lactation. This may account for the fact that some mothers have such an abundant milk supply while others have difficulty meeting their babies' needs. (See Figure 1 on the next page.)

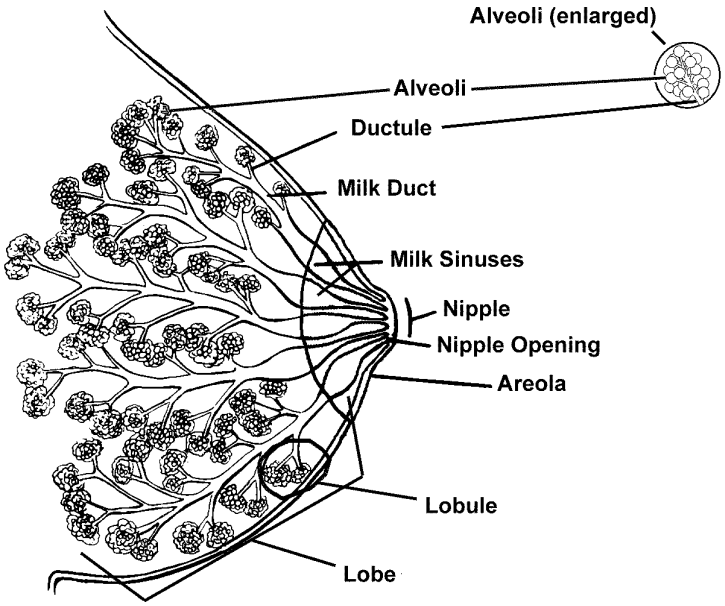

Figure 1. Structure of the human breast during lactation.

- **Connective Tissue**

The breast contains fibrous connective tissue that supports and contains the adipose tissue, milk producing and transport tissues, and all the other parts of the organ. Some fibrous bands attach the breast to the overlying skin and underlying fibrous tissue enclosing the muscles. These bands are known as Cooper's ligaments and keep the breast from sagging. Other connective tissue hold the segments of the breast together and support the ducts as they fill with milk. All the fibers elongate and increase in number as the breast grows during pregnancy, and they expand further during lactation.

Some women notice their breasts sagging after pregnancy and lactation. It is more likely that these changes are due to pregnancy and hereditary factors, as the same effects are observed in women who feed their infants human milk substitute.

- **Blood and Lymph Systems**

All nutrients needed by the breast cells are provided by the bloodstream. Fluids containing these nutrients pass through the capillaries to the tissue spaces where they are absorbed by the cells. When the need for nutrients is increased - during menstruation, pregnancy, and lactation - the blood flow increases in response.

The lymphatic system absorbs the excess fluids from the tissue spaces and transports it mainly to the axillary lymph nodes in the armpit. Lymph nodes function as the filters in

the lymph system, trapping bacteria and degradated cell parts. A swelling of a lymph node in the armpit could suggest that an infection is present in the breast, arm, or hand.

If the breast becomes engorged, there is a stoppage of the flow of blood and lymph due to the increase pressure from milk in the ducts. This results in edema. The chances of a local infection are increased during this time, because bacteria and cell debris are not being adequately removed from the breast. In order to reduce the pressure in the breast, the milk should be removed as quickly and efficiently as possible.

- **Nerves**

The breast contains sensory nerves which trigger lactation. The epidermis of the nipple and areola are supplied with few nerves, while the deeper parts, the dermis and glandular tissue, are amply supplied. These deeper nerves are highly responsive to suckling stimulation, which initiate milk production and release mechanisms and activate the Montgomery glands and milk duct openings. This is why it is important for the baby to grasp the nipple and areola well and to suckle vigorously. Inadequate stimulation to the deeper nerves results in decreased milk production and a less effective MER.

- **Adipose Tissue**

The fat cells in the breast cushion the organ. Fat cells are found throughout the breast, between lobules, ducts, and under the skin. There is no fat deposited immediately beneath the areola and nipple, since these areas are dominated by muscle tissue and the lactiferous sinuses.

The size of the breast is mainly determined by the amount of adipose tissue present. It is not a predictor of a woman's ability to produce milk. Women with large or small breasts can nurse equally well.

- **Areola**

The areola is the dark circular area around the nipple which enlarges in size and becomes darker during puberty, menstruation, and pregnancy. The darker color of the areola and nipple is thought by some to be a visual sign to aid the newborn in finding the breast. Since the areola covers the lactiferous sinuses, the baby's mouth should envelop as large a portion of the areola as possible, in order for his gums to compress the milk out of the sinuses.

- **Montgomery Glands**

The areola is also the site of the Montgomery glands - small sebaceous glands that secrete an oily substance which provides lubrication and alters the pH of the skin, discouraging the growth of bacteria on the nipple and areola. These glands enlarge during pregnancy and have a pimply-like appearance. Because the secretions contain antibacterial properties, washing the nipples with soap is not recommended. Further, it may cause drying and cracking of the nipple, making the nipple and areola more prone to soreness. Daily washing with warm water while bathing is all that is needed.

- **Nipple**

The nipple extends and becomes firmer when stimulated to provide a means for the baby to grasp it easily. It is flexible and can be molded so that it will conform to the baby's mouth while he is nursing. The nipple contains the nerve endings which trigger the production and release of milk. Each nipple contains fifteen to twenty-five ductule openings. Only six or seven function during a particular feeding and these alternate from one feeding to the next. These ductule openings are located at the end of the nipple and enable the baby to receive the milk.

Breast Physiology

According to Dr. Ruth Lawrence, lactation is divided into three phases - mammogenesis (the growth of the mammary glands), lactogenesis (the initiation of milk production), and galactopoiesis (the maintenance of the milk supply).

- **Mammogenesis**

Mammogenesis or breast development begins during the fourth week of gestation when primary and secondary ducts develop. Mammary gland development during childhood is limited to general growth.

At puberty, estrogen becomes the major influence on breast growth in a girl, when primary and secondary ducts grow and divide along with an increase in the number of and development of lobuloalveolar units. Breast changes continue to occur during each menstrual cycle in response to the changes in hormones. Complete development of mammary function occurs only in pregnancy.

During pregnancy, several hormones control breast development - estrogen, progesterone, adrenocorticotropic hormone (ACTH), prolactin, and growth hormone. The breasts grow larger, the skin appears thinner, the diameter of the areola increases, and the veins become more prominent. As the nipples become more erect, pigmentation of the areola increases and the Montgomery glands enlarge. Estrogen causes the ductal system to proliferate and differentiate, while progesterone promotes an increase in the size of the lobes, lobules, and alveoli. ACTH and growth hormone combine with prolactin and progesterone to promote mammary growth.

• Lactogenesis

Lactogenesis is the onset of milk secretion. During the second half of pregnancy, secretory activity accelerates and colostrum is produced. After 16 weeks of pregnancy, lactation occurs even if the pregnancy does not progress. The capacity of the breast to secrete milk during later pregnancy is called lactogenesis stage 1, or lactogenesis 1.

Lactogenesis stage 2 occurs after birth (days two or three to eight postpartum) with the onset of copious milk secretion. During lactogenesis 2, milk volume increases rapidly from 36 to 96 hours postpartum and then abruptly levels off. It is accompanied by a significant fall in breastmilk levels of sodium chloride and protein and a rise in lactose and lipids. Prolactin levels remain high following birth if suckling occurs.

Lactogenesis is triggered following the expulsion of the placenta by a fall in progesterone and estrogen levels and continued presence of prolactin. As progesterone and estrogen levels abruptly drop, the anterior pituitary gland, no longer inhibited by these two hormones, releases very large amounts of prolactin (See Figure 2.). Prolactin levels rise and fall in proportion to the frequency, intensity, and duration of nipple stimulation and the suckling stimulus. During the first week postpartum, prolactin levels in breastfeeding women drop about 50 percent. If a mother does not breastfeed, prolactin levels usually reach nonpregnant levels by seven days postpartum.

Research on prolactin levels during breastfeeding reveal the following:

- Prolactin levels decline slowly over the course of lactation, but remain elevated for as long as the mother continues to breastfeed.
- The level of prolactin is related with the frequency of suckling: the more feedings, the higher the prolactin level. More than eight breastfeedings per 24 hours prevent decline of the concentration of prolactin before the next feeding.
- Prolactin levels are higher in amenorrheic than in cycling women during the first year postpartum. Prolactin delays fertility. It delays the return of ovulation by inhibiting the ovarian response to follicle-stimulating hormone (FSH).
- Prolactin may be affected by smoking and beer. Smoking may reduce prolactin levels; drinking a beer may increase prolactin levels.

• Galactopoiesis

Galactopoiesis, or the maintenance of a milk supply, requires removal of milk from the breast. When milk is not removed or not removed adequately, capillary blood flow decreases and the lactation process can be inhibited. It is the quantity and quality of infant suckling or milk removals that controls breastmilk synthesis. Milk production reflects the infant's appetite rather than the woman's ability to produce milk. As long as milk is regularly removed, the alveolar cells will continue to secrete milk.

This phenomenon, called the supply-demand response, is a feedback control that regulates the production of milk to match the infant of the infant.

- **Milk Ejection Reflex**

The milk ejection reflex (MER), sometimes called "let-down," is the reflex that causes the alveoli to release the milk they have made. When the baby suckles at the breast and stimulates the nipple, a message is sent up the nerve pathways to the posterior pituitary gland. The hormone oxytocin is released and causes the muscles around the alveoli to contract and push the stored milk down the ducts through the collecting sinuses and out the nipple pores - the MER (See Figure 3.). Some women may actually feel this initial MER as a tingling or tightening sensation, pressure, leaking, or uterine cramps; others do not. There are several MERs during a nursing session, but the first one is usually the one felt, if at all.

Oxytocin plays a critical role in the continuance of lactation. Levels in the blood rise within one minute of breast stimulation, remain elevated during stimulation, and return to baseline levels within six minutes after cessation of nipple stimulation.

The MER has a strong psychological base. Emotional upsets, stress, embarrassment, severe cold, certain drugs, anxiety, pain, discomfort, excessive nicotine, caffeine, or alcohol intake, or inadequate rest may inhibit the MER. If no MER occurs, the infant becomes frustrated and cries more, thus creating further stress. If continued, this cycle can lead to an inadequate milk supply.

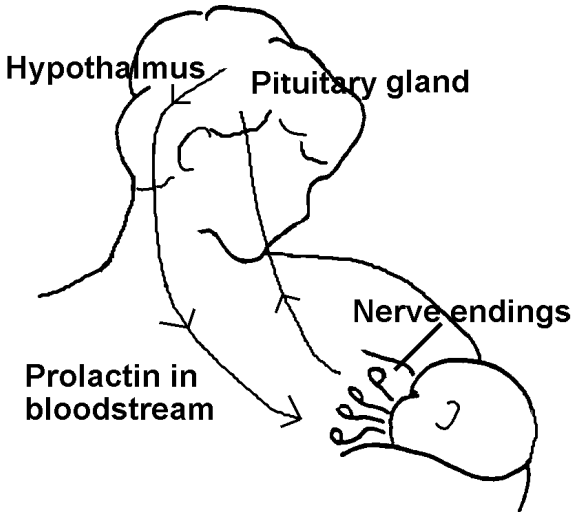

Figure 2. Milk Production.

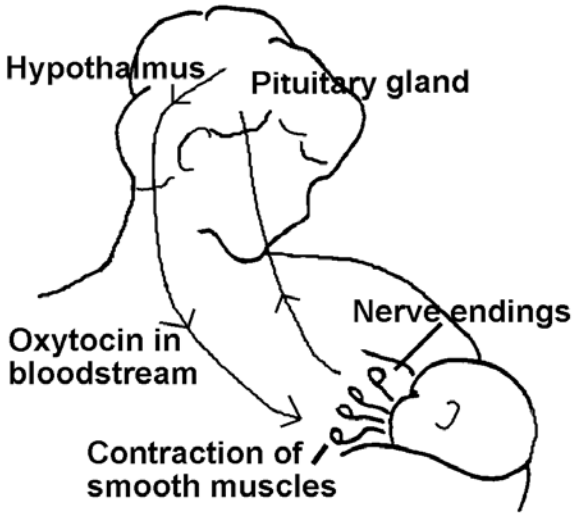

Figure 3. Milk Ejection Reflex.

The amount of milk produced in early breastfeeding is proportional to the amount of prolactin released. Levels increase in proportion to the amount of nipple stimulation. Therefore, lactation is most successful when all barriers to early and frequent feedings are eliminated. Common barriers include separation of the mother

and baby after birth, test feedings with a bottle, scheduled feedings, restricted feedings, supplemental feeds of water, glucose or human milk substitutes, and the use of pacifiers.

- **Milk Volume**

The amount of milk an infant takes is usually referred to as milk volume. The primary way of estimating milk volume is test weighing. The infant is weighed, without a diaper, before and after a feed.

There are wide variations in the milk intake of healthy, exclusively breastfed infants. Average intakes can range between 700 and 800 gm/day in the first four to five months. However, that range of intake is 450-1200 gm/day (National Academy of Sciences, 1991). After four to five months of age, milk intake can vary even more.

Study Questions - Chapter 3

1. Name the parts of the breast.

2. What are the main functions of the glandular tissue?

3. Why is it important for the baby to properly grasp the nipple and areola?

4. What is lactogenesis?

5. What is galactopoiesis?

6. What hormone is necessary for milk production?

7. What is oxytocin?

8. What is the common name for the milk ejection reflex?